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REMARKS

Entry of this Amendment is proper since it narrows the issues on appeal and does not require further search by the Examiner.

Claims 1-20 are all the claims presently pending in the application. Claims 1-3, 6, 12 and 17-20 have been amended to more particularly define the invention.

It is noted that the claim amendments are made only for more particularly pointing out the invention, and not for distinguishing the invention over the prior art, narrowing the claims or for any statutory requirements of patentability. Further, Applicant specifically states that no amendment to any claim herein should be construed as a disclaimer of any interest in or right to an equivalent of any element or feature of the amended claim.

Claims 12 and 18-20 stand rejected upon informalities (e.g., 35 U.S.C. § 112, first paragraph). Claims 1-17 and 19-20 stand rejected under 35 U.S.C. § 102(e) as being anticipated by Taniuchi, et al. (U.S. Patent No. 6,013,393). Claims 1-17 and 19-20 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Hasegawa, et al. (U.S. Patent No. 5,972,539). Claims 1 and 18 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Hasegawa, et al., in view of Poehler, et al. (U.S. Patent No. 5,637,421). Claim 18 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Taniuchi, et al., in view of Poehler, et al.

These rejections are traversed in view of the following discussion.

I. THE CLAIMED INVENTION

The claimed invention (e.g., as defined by claim 1) is directed to a lithium battery which includes a power-generating element having a positive electrode, a negative electrode and a separator, at least a part of the power-generating element including a gel electrolyte which includes a polymer and a liquid electrolyte.

Importantly, Applicant's invention includes a gel electrolyte which includes a liquid electrolyte having a concentration of lithium salt in a range from 2 to 4 mols per liter of the liquid electrolyte, and a polymer including a polymerized polyfunctional (meth) acrylate monomer, the gel electrolyte including the polymerized polyfunctional (meth) acrylate monomer in a range from 5% to 30% by weight.

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As explained in the Application, conventional lithium batteries include a gel electrolyte having a liquid electrolyte which includes a low amount of a lithium salt (e.g., less than 1.5 mols per liter) (Application at page 3, lines 10-20). However, in such conventional batteries the diffusion of lithium ion cannot overtake the demand rate of lithium ion required by the positive electrode during high rate discharge, making it difficult to keep the battery performance at a sufficient level (Application at page 3, line 21-page 4, line 1).

The claimed invention, on the other hand, includes a gel electrolyte having a liquid electrolyte which includes a concentration of lithium salt in a range from 2 to 4 mols per liter of the liquid electrolyte, and a polymer including a polymerized polyfunctional (meth) acrylate monomer, the gel electrolyte including the polymerized polyfunctional (meth) acrylate monomer in a range from 5% to 30% by weight. This allows the inventive battery to provide a better (e.g., high rate) discharge capacity performance than conventional batteries (Application at page 10, lines 8-13).

As explained in the Application, the inventors conducted extensive studies and found that this range of lithium salt concentration in a liquid electrolyte, combined at least with this range of weight percent of a monomer in the gel electrolyte, helps to provide a lithium battery which is reliable, has a high rate charge and discharge performance, low temperature performance, and safety performance (Application at page 5, line 9-page 6, line 11).

II. THE 35 USC §112, FIRST PARAGRAPH REJECTION

Claims 12 and 18-20 stand rejected under 35 U.S.C. §112, first paragraph. Applicant would submit, however, that these claims are fully enabled.

Specifically, Applicant would point out that claim 12 has been amended to recite "*wherein said liquid electrolyte comprises from 2 to 3 mols per liter of said lithium salt*", and claims 19-20 have been amended to recite "*a liquid electrolyte comprising from 2 to 4 mols per liter of said lithium salt*". These features are clearly described in the Application, for example, at page 5, line 9-page 6, line 11.

In addition, claim 18 has been amended to recite "*wherein said polyfunctional (meth) acrylate monomer comprises a trifunctional (meth) acrylate monomer*". This is clearly described in the Application at page 9, line 2.

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III. THE PRIOR ART REFERENCES

A. The Taniuchi Reference

The Examiner alleges that Taniuchi teaches the claimed invention of claims 1-17, 19 and 20. Applicant would submit, however, that there are elements of the claimed invention which are neither taught nor suggested by Taniuchi.

Taniuchi discloses an ionic conductive polymer gel for a secondary battery. The battery has an electrolyte salt component which includes a sulfonated derivative with formula $\text{LiX}(\text{SO}_2 \text{R}^1)_n$, where X is N, C, B, O or $-\text{C}(\text{R}^2)_m-$ in which R^2 is a hydrogen atom, an alkyl group having 1 to 12 carbon atoms, and m is an integer of 1 to 2, R^1 is a halogenated alkyl group having 1 to 12 carbon atoms, and n is an integer of 1 to 3, a non-aqueous solvent, and a polymer matrix prepared by polymerizing a polymerizable material including at least one (meth) acrylate monomer with a molecular weight of 1000 or less, in the presence of the electrolyte salt component and the non-aqueous solvent. A lithium-ion battery utilizes the ionic conductive polymer gel (Taniuchi at Abstract).

Applicant would submit, however, that Taniuchi does not teach or suggest a gel electrolyte including *"a polymer comprising a polymerized polyfunctional (meth) acrylate monomer, said gel electrolyte comprising said polymerized polyfunctional (meth) acrylate monomer in a range from 5% to 30% by weight; and a liquid electrolyte, a concentration of lithium salt in said liquid electrolyte being in a range from 2 to 4 mols per liter of the liquid electrolyte"*, as recited, for example, in claim 1.

As explained in the Application, conventional lithium batteries may use a gel electrolyte. However, the lithium salt concentration in the electrolyte solution is low (e.g., less than 1.5 mols per liter), and the polymer used in the electrolyte solution is typically polyethylene oxide (Application at page 3, lines 10-20). Thus, in such conventional batteries the diffusion of lithium ion cannot overtake the demand rate of lithium ion required by the positive electrode during high rate discharge, so that the battery performance cannot be maintained.

Applicant's invention, on the other hand, includes a lithium battery in which a concentration of lithium salt in the liquid electrolyte is in a range from 2 to 4 mols per liter of the liquid electrolyte, and the polymer includes a polymerized polyfunctional (meth) acrylate

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monomer, the gel electrolyte including the polymerized polyfunctional (meth) acrylate monomer in a range from 5% to 30% by weight (Application at page 5, line 9-page 6, line 11).

Specifically, as explained in the Application, the inventors conducted experiments in which a gel electrolyte separator was prepared by mixing a liquid electrolyte (e.g., a lithium salt was dissolved in an organic solvent) with a polyfunctional (e.g., bifunctional) (meth) acrylate monomer (Application at page 13, lines 6-16). The discharge capacity at 20°C was then measured for varying amounts of the lithium salt molar concentration.

As illustrated in Table 1, the discharge capacity of the samples, for a range of the lithium salt molar concentrations which is above that of conventional devices were higher than those outside of the range (Application at page 18, lines 6-8; Table 1 on page 18).

Clearly, Taniuchi does not teach or suggest these features of the claimed invention. Indeed, as explained in the Application, the inventors of the present invention have found that when the concentration of salt is adjusted within the range recited in the claim, in the case where the concentration of polymer is within the range recited in the claim, the excellent battery performance which is unexpected from the conventional technique can be exhibited, and have achieved the present invention.

It has been a matter of common knowledge among skilled artisans that the concentration of salt in the electrolyte is selected in such manner that the highest ion conductivity can be obtained as to the conventional battery with an organic liquid electrolyte. The common-sense concentration of salt is within the range of about 0.5 mol/liter to about 1.5 mol/liter.

The prior art may teach that the broad concentration of salt exceeding that of from about 0.5 mol/liter to about 1.5 mol/liter can be applied. However, it is believed to be unexpected even by a skilled artisan that when the concentration of salt is adjusted within the range recited in the claim which includes higher concentration of salt exceeding range common-sense among skilled artisans, in the case where the concentration of polymer is within the range recited in the claim, the excellent battery performance which is described in the working example can be exhibited.

A reason why the advantage of the present invention can be obtained is described in the specification of the present Application (e.g., see Application at page 5, lines 9-24; page

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9, line 22-page 10, line 13). In short, in a gel electrolyte battery, the gel electrolyte is characterized in that it does not flow, which is different from the case of a liquid electrolyte battery. In this case, noting the movement of an ion in the electrolyte, a lithium ion is moved from a negative electrode to a positive electrode during discharge. At this moment, because the transference number of the lithium ion in the electrolyte is not one (1) (for example, about 0.2 to about 0.5), the slope in concentration arises in such a manner that the counter anion is biased to the negative electrode side and the concentration of the anion is exhausted in the vicinity of the positive electrode conversely.

However, according to the principle of electrical charge compensation, the slope in concentration of anion means the slope in concentration of lithium salt (i.e., an ion pair of a lithium cation and an anion). That is, the concentration of salt is increased in the vicinity of the surface of negative electrode, whereas the concentration of salt is decreased in the vicinity of the surface of positive electrode.

Judging from the principle of electrical charge compensation, the slope in concentration is generated similarly whether the electrolyte is the liquid electrolyte or the gel electrolyte. However, when the liquid electrolyte is used, because the electrolyte easily flows and the above slope in concentration can immediately be solved by the flowing, no deterioration in performance arises. On the other hand, when the gel electrolyte is used, because the electrolyte does not flow, the reduction of the above slope in concentration is delayed in terms of time.

This phenomenon mainly acts on the charge reaction at the positive electrode. As discussed above, because the concentration of the salt is exhausted in the vicinity of the surface of the positive electrode, the impedance at the positive electrode side is increased, and therefore, the high rate discharge performance is deteriorated as compared with the case of using the liquid electrolyte.

In the present invention, the exhaustion of the salt in the vicinity of the positive electrode can be compensated for by intentionally employing the concentration of the salt higher than the common-sense range, by which the remarkable effects as described in the specification have been achieved. Clearly, this is not recognized by Taniuchi.

Contrary to the claimed invention, Taniuchi specifically teaches that the polymer used in the polymer gel has a molecular weight of 500 or less (Taniuchi at col. 4, lines 15-18).

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Specifically, Taniuchi prefers a monofunctional monomer (Taniuchi at col. 3, lines 53-55). Only a very minor amount (e.g., about 4 wt. % or less) of polyfunctional monomer may be used in the Taniuchi device (Taniuchi at col. 4, lines 30-39). This is completely different from the claimed invention in which the gel electrolyte includes a polymerized polyfunctional (meth) acrylate monomer in a range from 5% to 30% by weight.

Moreover, while Taniuchi may disclose a lithium ion concentration which is higher than the conventionally acceptable range (e.g., less than 1.5 moles per liter), this range is for a completely different battery and should not be considered the same as the same range of lithium salt in the battery of the claimed invention. That is, an acceptable lithium salt concentration in the battery may depend upon the type and concentration of polymer used.

Therefore, it would be meaningless to compare a lithium salt concentration, for batteries which include different types and concentration of polymer. Therefore, contrary to the Examiner's allegations, Taniuchi does not teach or suggest the battery of the claimed invention.

Applicant further notes that the function and effect of the present invention does not merely relate to increasing the lithium ion diffusion rate by increasing the concentration of salt. Indeed, as noted in the specification, when the concentration of salt is increased beyond an ordinary level, the diffusion rate may decrease. (e.g., see Application at page 6, lines 4-6). Instead, the function and effect of the present invention may relate to the fact that since a lithium ion meets with a demand rate of lithium ion required by the positive electrode by increasing the concentration of lithium salt, the exhaustion of salt in the vicinity of the positive electrode can be compensated for.

Therefore, Applicant respectfully submits that there are elements of the claimed invention that are not taught or suggest by Taniuchi. Therefore, the Examiner is respectfully requested to withdraw this rejection.

B. The Hasegawa Reference

The Examiner alleges that Hasegawa makes obvious the claimed invention of claims 1-17, 19 and 20. Applicant would submit, however, that there are elements of the claimed invention which are neither taught nor suggested by Hasegawa.

Hasegawa discloses a flame retardant solid electrolyte which includes an ion

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conductive polymer matrix having moieties capable of imparting flame retardance to the polymer matrix and ether bonds in the molecule and an electrolyte salt dispersed in the polymer matrix. The flame retardant solid electrolyte includes a non-ion-conductive polymer matrix and a liquid electrolyte consisting of an electrolyte salt dissolved in a solvent, which is dispersed in the polymer matrix. Further, the flame retardance-imparting moieties are derived from halogen or phosphorus-bearing compounds (Hasegawa at Abstract).

Applicant would submit, however, that Hasegawa does not teach or suggest a gel electrolyte including *"a polymer comprising a polymerized polyfunctional (meth) acrylate monomer, said gel electrolyte comprising said polymerized polyfunctional (meth) acrylate monomer in a range from 5% to 30% by weight; and a liquid electrolyte, a concentration of lithium salt in said liquid electrolyte being in a range from 2 to 4 mols per liter of the liquid electrolyte"*, as recited, for example, in claim 1. This is discussed in the Application, for example, at page 4, lines 12-20).

As noted above, conventional lithium batteries may use a gel electrolyte. However, the lithium salt concentration in the electrolyte solution is low, and the polymer used in the electrolyte solution is typically polyethylene oxide (Application at page 3, lines 10-20). Such conventional batteries have a slow diffusion of lithium ion during high rate discharge, so that the battery performance cannot be maintained.

Applicant's invention, on the other hand, includes a lithium battery in which a concentration of lithium salt in the liquid electrolyte is in a range from 2 to 4 mols per liter of the liquid electrolyte, and the polymer includes a polymerized polyfunctional (meth) acrylate monomer, the gel electrolyte including the polymerized polyfunctional (meth) acrylate monomer in a range from 5% to 30% by weight (Application at page 5, lines 9-24; page 8, line 19-page 9, line 10; page 10, lines 8-13; Table 1 on page 18; Figure 1).

Further, the Application explains that the lithium concentration in the liquid electrolyte is an important feature of the claimed invention. Indeed, if the lithium salt concentration is too low, the lithium ion concentration is small and the diffusion rate is small (Application at page 6, lines 2-4).

Clearly, Hasegawa does not teach or suggest these novel features. Indeed, Hasegawa is directed to a completely different subject matter from the claimed invention. That is, Hasegawa is merely intended to provide a flame retardant solid electrolyte by mixing a

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polymer with a halogen or phosphorus containing compound (Hasegawa at col. 3, lines 17-32). In fact, nowhere does Hasegawa even discuss at least one purpose (e.g., to provide a good (e.g., high rate) discharge performance) to which the claimed invention is directed).

The Examiner attempts to rely on col. 9, lines 1-65 to support his allegations. However, this passage merely teaches that the liquid electrolyte has a concentration of 0.5 to 2 moles/liter (Hasegawa at col. 9, lines 38-39). This is clearly outside of the claimed range of lithium salt of from 2 to 4 moles/liter.

Clearly, Hasegawa teaches a concentration which lower that the lithium salt concentration of the claimed invention. Therefore, it is clear that the Hasegawa device would not be able to provide the good (e.g., high rate) discharge performance provided by the claimed invention.

Further, as noted above, in the present invention, the exhaustion of the salt in the vicinity of the positive electrode can be compensated by intentionally employing the concentration of the salt higher than the common-sense range, by which the remarkable effects as described in the specification have been achieved. Clearly, this is not recognized by Hasegawa.

Moreover, as noted above, an acceptable lithium salt concentration in the battery may depend upon the type and concentration of polymer used. Therefore, it would be meaningless to compare a lithium salt concentration, for batteries which include different types and concentration of polymer.

Hasegawa does not teach or suggest a battery in which the gel electrolyte includes a polymerized polyfunctional (meth) acrylate monomer in a range from 5% to 30% by weight. Therefore, is would be incorrect to equate the lithium concentration in the battery of Hasegawa with that of the claimed invention. Therefore, contrary to the Examiner's allegations, Taniuchi does not teach or suggest the battery of the claimed invention.

Therefore, Applicant respectfully submits that there are elements of the claimed invention that are not taught or suggest by Hasegawa. Therefore, the Examiner is respectfully requested to withdraw this rejection.

C. The Poehler Reference

The Examiner alleges that Poehler would have been combined with Hasegawa to form

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the claimed invention of claims 1 and 18, and would have been combined with Taniuchi to form the claimed invention of claim 18. Applicant would submit, however, that these references would not have been combined and even if combined, the combination would not teach or suggest each and every element of the claimed invention.

Poehler discloses a method for producing a quasi-solid state charge storage device, having one or more electrochemical cells with a structure capable of being stacked or combined to form primary or secondary battery devices. Each cell is composed of an ionically conducting gel polymer electrolyte layer separating opposing surfaces of electronically conducting conjugated polymeric anode and cathode electrodes (Poehler at Abstract).

However, Applicant would submit that these references would not have been combined as alleged by the Examiner. Indeed, these references are directed to different problems and solutions. Specifically, Hasegawa is intended to provide a flame retardant solid electrolyte and Taniuchi is directed to a polymer gel which includes a sulfonated derivative lithium salt, whereas Poehler is merely intended to provide a lightweight device using a conjugated polymeric anode and cathode electrodes. Therefore, these references are completely unrelated, and no person of ordinary skill in the art would have considered combining these disparate references, absent impermissible hindsight.

Further, Applicant would submit that the Examiner can point to no motivation or suggestion in the references to urge the combination as alleged by the Examiner. Indeed, the Examiner merely states that it would have been obvious to combine these references "to increase the area of the electrodes in the battery of Hasegawa ... because the required discharge capacity of the battery depends on the particular needs of an electronic application". However, this fails to explain why one of ordinary skill in the art would combine these references. Therefore, Applicant would respectfully submit that one of ordinary skill in the art would not have been so motivated to combine the references as alleged by the Examiner. Therefore, the Examiner has failed to make a prima facie case of obviousness.

Moreover, neither Poehler, nor Hasegawa, nor Taniuchi teaches or suggests a gel electrolyte including "*a polymer comprising a polymerized polyfunctional (meth) acrylate monomer, said gel electrolyte comprising said polymerized polyfunctional (meth) acrylate monomer in a range from 5% to 30% by weight; and a liquid electrolyte, a concentration of*

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lithium salt in said liquid electrolyte being in a range from 2 to 4 mols per liter of the liquid electrolyte", as recited, for example, in claim 1. This is discussed in the Application, for example, at page 4, lines 12-20).

Clearly, Poehler does not teach or suggest these novel features. Indeed, the Examiner has not alleged that Poehler teaches or suggests such a feature. Instead, the Examiner merely relies on Poehler as allegedly disclosing a particular discharge capacity.

In fact, Poehler is directed to a completely different subject matter from the claimed invention. That is, Poehler is merely intended to provide a lightweight device using a conjugated polymeric anode and cathode electrodes. Nowhere does Poehler teach or suggest a gel electrolyte of the claimed invention. In fact, Poehler teaches that the molar concentration of the salt in an electrolyte solution should be from 0.1 to 1 moles per liter (Poehler at col. 6, lines 16-21). Obviously, this is completely different from the claimed invention.

Thus, Poehler clearly does not teach or suggest a gel electrolyte including a polymerized polyfunctional (meth) acrylate monomer in a range from 5% to 30% by weight, and a liquid electrolyte, a concentration of lithium salt in said liquid electrolyte being in a range from 2 to 4 mols per liter of the liquid electrolyte. Thus, Poehler does not make up for the deficiencies of either Hasegawa or Taniuchi.

Therefore, Applicant would submit that these references would not have been combined as alleged by the Examiner and even if combined, the combination would not teach or suggest each and every element of the claimed invention. Therefore, the Examiner is respectfully requested to withdraw this rejection.

IV. FORMAL MATTERS AND CONCLUSION

The title has been amended to be more indicative of the invention to which the claims pertain and to overcome the Examiner's objection to the title.

In view of the foregoing, Applicant submits that claims 1-20, all the claims presently pending in the application, are patentably distinct over the prior art of record and are in condition for allowance. The Examiner is respectfully requested to pass the above application to issue at the earliest possible time.

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Should the Examiner find the application to be other than in condition for allowance, the Examiner is requested to contact the undersigned at the local telephone number listed below to discuss any other changes deemed necessary in a telephonic or personal interview.

The Commissioner is hereby authorized to charge any deficiency in fees or to credit any overpayment in fees to Attorney's Deposit Account No. 50-0481.

Respectfully Submitted,

Date: 1/7/04



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CERTIFICATION OF FACSIMILE TRANSMISSION

I hereby certify that I am filing this Amendment Under 37 C.F.R § 1.116 by facsimile with the United States Patent and Trademark Office to Examiner Susy N. Tsang Foster, Group Art Unit 1745 at fax number (703) 872-9306 this 7th day of January, 2004.



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